Executive Summary

CONSERVATION STRATEGY FOR TAHOE YELLOW CRESS (*Rorippa subumbellata*)

August 2002

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I. INTRODUCTION AND BACKGROUND

Tahoe yellow cress (*Rorippa subumbellata* Roll.) is a rare plant species endemic to the shores of Lake Tahoe in California and Nevada. It was listed as endangered by the State of California in 1982 (California Fish and Game Code 2050 *et seq.*) and is considered endangered throughout its range by the California Native Plant Society (Skinner and Pavlik 1994). Tahoe yellow cress is state-listed as critically endangered in Nevada (Nevada Revised Statutes 527.270 *et seq.*), and is considered threatened by the Northern Nevada Native Plant Society (Nevada Natural Heritage Program 2001). It is classified as a candidate species for listing under the Endangered Species Act of 1973, as amended (64 FR 57533).

Survey results through the year 2000 showed that Tahoe yellow cress occupied only 27 percent of the known, historic sites (Figure A). Evidence suggests the current decline in the number of sites occupied by Tahoe yellow cress is primarily due to: Alterations in lake level dynamics caused by construction and operation of the Truckee River outlet dam and reservoir; destruction of actual and potentially suitable habitat by the construction of piers, jetties, and other structures; high levels of recreational activity associated with beaches and dunes; disturbance of the sand by public and private property maintenance activities; and possibly random environmental events. Because of the imminent threats facing the species, a task force has been formed to develop and implement a conservation strategy for Tahoe yellow cress. The strategy is coupled with a Memorandum of Understanding (MOU)/conservation agreement (CA) signed by the participating entities that demonstrates the commitment of all involved to the long-term protection of the species.

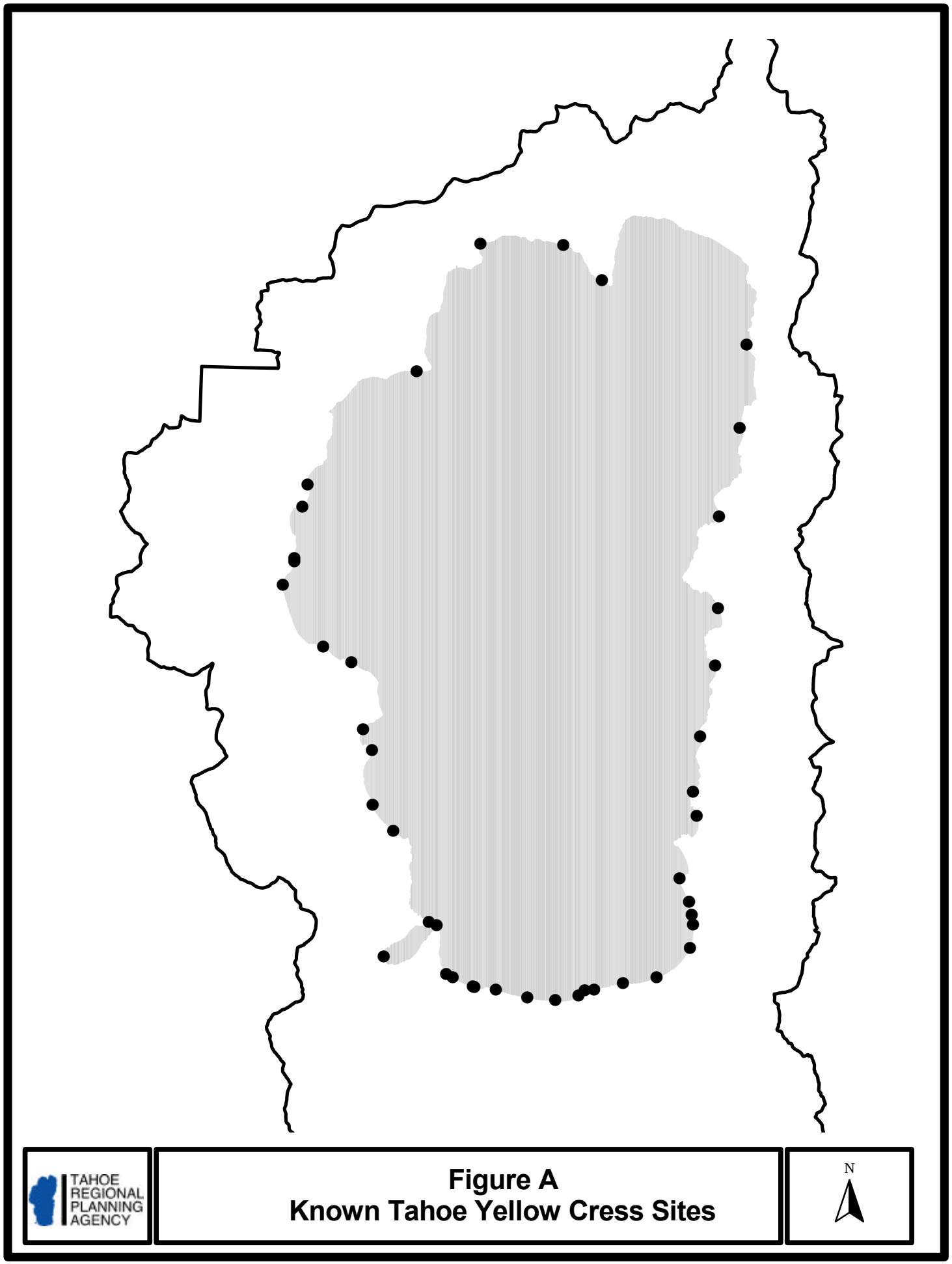
Implementation of the strategy is a cooperative effort being carried out under the auspices of a multi-agency and private interest group task force. The task force is composed of a technical advisory group (TAG) and an executive committee (Appendices A and B). The TAG is comprised of biologists and public land managers who represent the resource and regulatory agencies around the Lake Tahoe basin. In addition, TAG members include representatives of private property owners and environmental groups. The executive committee is made up of managers and directors representing public and private interests in the basin. The TAG and executive committee, together with academicians with expertise in rare plant ecology and conservation biology, developed this strategy. The TAG will bring future management recommendations to the executive committee. These recommendations will be based on the previous year's data and historical knowledge. The executive committee will act in the

decision-making capacity and continue to oversee the implementation of conservation and management actions through the adaptive management process.

The following entities have committed to the implementation of the conservation strategy and are signatory to the MOU/CA:

- Tahoe Regional Planning Agency
- U.S. Fish & Wildlife Service
- U.S. Forest Service
- Nevada Division of Forestry
- Nevada Division of State Lands
- Nevada Division of State Parks
- Nevada Natural Heritage Program
- California State Lands Commission
- California Department of Fish & Game
- California Department of Parks & Recreation
- California Tahoe Conservancy
- Tahoe Lakefront Owners' Association
- League to Save Lake Tahoe

This list is of those entities that developed the conservation strategy. It is hoped that other private landowners and local agencies will also wish to participate in the conservation strategy in the future.


TAHOE
REGIONAL
PLANNING
AGENCY
Figure A
Known Tahoe Yellow Cress Sites
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II. CONSERVATION STRATEGY

Tahoe Yellow Cress and Lake Tahoe

It is impossible to know exactly how Tahoe yellow cress came to be. Almost all of its relatives are plants associated with flowing water - inhabitants of rivers, streams, and meadow edges. Such habitats undoubtedly existed in the Lake Tahoe basin over the millennia and, in fact, still do. Tahoe yellow cress is largely confined to the sandy beach and dunes associated with the ever-changing margin of the lake and the mouths of its tributaries. Such habitat preference is unusual because no other lakeside endemics are known from the Sierra Nevada. Perhaps other lakes are simply too young to have fostered the development of a unique lakeshore plant. Lake Tahoe has existed for about two million years, never displaced by glaciers and never static in size, shape, or other essential qualities. Age and environment have thus conspired to create a singular species in a place as singular as the clear blue waters.

The lake itself, especially its age, complex history, and dynamics, is theorized to be the primary force in the evolution of Tahoe yellow cress. Great oscillations in climate caused glaciers to advance and retreat, with corresponding fluctuations in precipitation, runoff, evaporation, and groundwater recharge. Lake levels rose and fell, sometimes slowly and sometimes catastrophically over short periods. Submerged tree trunks indicate lake levels 20 to 40 feet (ft) (6 to 12 meters (m)) lower in the recent past, but other evidence shows levels were more than 570 ft (175 m) lower over the last 160,000 years. If a 1-ft (0.3-m) drop in water level today could create roughly 200 acres (ac) (80 hectares (ha)) of sandy shoreline habitat suitable for Tahoe yellow cress, imagine the potential habitat created by lake recession during the distant past.

Only Lake Tahoe, never static and never fully glaciated, could have fostered this unique plant.

With such a long history of rapid, unpredictable change, it is remarkable that this plant has persisted. Extreme climate change, extraordinary high waters, even landslides and lake tsunamis could have led to extinction of Tahoe yellow cress, especially when it was composed of a few, small, isolated populations. The tenacity of those populations probably results from the possession of a perennial habit and spreading rootstocks. The rootstocks can branch and grow in many directions, allowing a long-lived individual to occupy upslope and downslope habitat and be less susceptible to stresses imposed by the water's edge. They can rapidly spread into new, open sands as the lake recedes, provide upslope anchorage and refuge when the lake advances, and remain dormant during erosion caused by wave action. The rootstocks are apparently tolerant of low sediment oxygen because despite years of inundation they are able to germinate and produce leafy shoots. Under extreme conditions, rootstocks and seeds are liberated by the churning waters and float to new sites for possible colonization. This diminutive, unassuming plant has proven itself ferocious in its quest for existence, not only weathering the severe forces of Lake Tahoe for hundreds of thousands of years, but incorporating those forces into a unique physical and physiological form.

Biological Overview of Tahoe Yellow Cress

The current treatment of *Rorippa* (Brassicaceae, or mustard family) in the *Jepson Manual: Higher Plants of California* (Hickman 1993) recognizes about 75 species worldwide, with 21 native to North America, and 7 having been introduced to the continent. There is a concentration of taxa, some common and some rare, associated with the mountainous regions of the western United States (Stuckey 1972). California has 11 species, one of which is introduced from Europe, and one that is considered worldwide in its distribution (water cress, *R. nasturtium-aquaticum*). Nevada has eight species. All are associated with open, damp, or wet habitats (springs, marshes, meadows, mudflats, playas, and the shores or banks of lakes, streams, and rivers) that are often naturally disturbed by flowing water. Anthropogenic wetlands also provide habitat, especially irrigation ditches, farm ponds, and road culverts.

Tahoe yellow cress is a low-growing, somewhat fleshy, herbaceous perennial that branches profusely. Flowers are yellow and have four petals. Flowering occurs between late May and late October. Seed and fruit development is continuous during the flowering period, truncated by inundation or the first winter storms. Tahoe yellow cress has a strong preference for sandy beach habitat. A quantitative 1990 survey indicated that nearly 60 percent of known Tahoe yellow cress occurrences were on substrates composed of greater than 75 percent sand, while only 16 percent were on substrates with less than 50 percent sand (California State Lands Commission (CSLC) 1998).

Conceptual Model of Metapopulations Dynamics

Tahoe yellow cress can persist over long periods because it possesses a population dynamic in which extirpation is countered by colonization. New, unoccupied sites can be colonized, old occupied sites can be recolonized or extirpated, and the timing and probabilities of these events could be influenced by many factors.

This population dynamic is referred to as a "metapopulation dynamic." Hanski and Gilpin (1991) defined metapopulation as a "set of local populations within some larger area, where typically migration from one local population to at least some other patches is possible." The elements of a metapopulation dynamic for Tahoe yellow cress can be summarized by the relationship:

$$dP/dt = CP(1-P) - E(P)$$

Where:

- **dP/dt** the metapopulation dynamic (positive or negative change in occupied sites/unit of time)
- **P** the proportion of occupied sites (i.e. actual habitat)
- **1 – P** the proportion of unoccupied sites (i.e. potential habitat)
- **C** colonization probability
- **E** extirpation probability (Hanski and Simberloff 1997; Ricklefs 1997)

A positive dynamic (rate of population gain greater than 0) is determined by a high colonization probability, a low extirpation probability, and a medium-high proportion of unoccupied sites (i.e. an abundance of potential habitat).

Several indirect lines of evidence support the hypothesis that Tahoe yellow cress exists as a complex of metapopulations. First, local extirpation and colonization have been observed over the 22-year history of Tahoe yellow cress monitoring along the shores of Lake Tahoe. The second line of evidence for metapopulation dynamics is that seedlings of Tahoe yellow cress are often observed in the "bathtub" ring of organic matter deposited on berms, in beach depressions, and on foredune areas by rising lake levels, tides, wind, and storm waves (Ferreira 1988; CSLC 1998; M. Falkner, CSLC, pers. comm. 2000). Finally, the apparent lack of genetic variation among surveyed Tahoe yellow cress populations is consistent with the idea of migratory exchange of alleles in a highly mobile, outbreeding species.

Fundamentally, the conservation of this species relies on our understanding of the metapopulation biology of this species (Section II.C, Conceptual Model of Metapopulations Dynamics). The key aspects of the biology of this plant are the colonization rate, the extirpation rate, the number of occupied sites, and the number of unoccupied sites. Table 5 lists the elements that are readily manipulated by resource management that may affect aspects of the species' biology. These elements are the focus of the conservation strategy in general and the focus of public and private lands specifically.

Analysis of Existing Data

Since it was first scientifically described by Dr. Reed Rollins in 1941, Tahoe yellow cress has been collected or observed at 51 locations around the lake. Not all known occurrences have been occupied by Tahoe yellow cress at the same time. The greatest number of occupied sites was 35 in 1993 (79 percent occupation of those sites surveyed in that year), while the fewest was 7 during the 1995 to 1997 period (about 20 percent occupation of those sites surveyed). The last complete survey (September 2000) found 14 occupied sites (33 percent occupation of those sites surveyed). It is not known exactly how many sites Tahoe yellow cress should occupy in a given year to secure its future, but the vast majority of endangered plants of highest conservation concern are found in five or fewer occurrences. Tahoe yellow cress finds itself on the cusp of endangerment, occupying 20 percent of its actual habitat during the worst of times and less than 80 percent during the best.

Twenty-two years of monitoring data for Tahoe yellow cress were analyzed and evaluated. This analysis consists of 30 pages of text, 14 figures, 5 tables, and 14 pages of description of the methods in the appendix. One of the derived products from this analysis is a ranking of the known Tahoe yellow cress sites (Table A – corresponds to Table 13 in strategy). Based on a viability index, four categories were developed: Core sites, high priority restoration sites, medium priority restoration sites, and low priority restoration sites. Sixteen sites are currently unranked, but will be ranked by the TAG in early 2002.

Table A. Ranking of known Tahoe yellow cress sites (ownership/management in parentheses).

Core Sites
Taylor Creek (USFS)
Upper Truckee E (CTC)
Tallac Creek (USFS)
Edgewood (Private)
Blackwood S (Placer Co)
Blackwood N (Private)

High Priority Restoration Sites
Kahle/Nevada Beach (USFS/Pvt)
Glenbrook (Private)
Eagle Creek (CDPR)
Ward Creek (Private)
Meeks Bay (USFS)
Cascade (Private)

Medium Priority Restoration Sites
Upper Truckee W (CTC)
Rubicon Bay (Private)
Emerald Point (CDPR)
Zephyr Cove (USFS)
4-H (U Nevada)
Baldwin Beach (USFS)
Timbercove (Private/Public)
Logan Shoals (Private)
Eagle Point (CDPR)
Tahoma (Private)
Tahoe Keys/Lighthouse (Private)
Tahoe Meadows (Private)

Low Priority Restoration Sites
Pope/Kiva (USFS)
Sand Harbor (Nevada)
El Dorado Beach (City SLT)
Secret Harbor (USFS)
Regan/Al Tahoe
(Public/Private)

Conservation on Public and Private Lands

This species, regardless of the actions of public agencies, cannot be protected without a stewardship ethic of private landowners.

The encouragement of this stewardship will be the central challenge of this conservation strategy.

The difference in conservation focus on public verses private lands is based on affecting different aspects within the metapopulation model: **$dP/dt = CP(1-P) - E(P)$**. The types of impacts and the ability of resource managers to influence those impacts are variable. Attempting to implement identical conservation and management practices on public and private lands may have vastly different results.

This species, regardless of the actions of public agencies, cannot be protected without stewardship by private landowners. Only two-thirds of the core and high priority sites and half of the medium priority sites are under public management (Table A). In addition to the ownership/management of populations, colonization of potentially suitable habitat is critical to this species, and private landowners manage a majority of potential habitat within the basin. To meet the ecological requirements of this species, which exhibits a metapopulation dynamic, both public and private lands are necessary for successful conservation. Engaging private landowners and encouraging their support of a stewardship program will be the central challenge of this conservation strategy. There are a number of barriers to private stewardship: 1) Concern that having Tahoe yellow cress on one's property will prevent a landowner from developing their land; 2) a lack of awareness about Tahoe yellow cress; and 3) timing of the project review process. Each of the barriers has been addressed within this conservation strategy.

The policies and guidelines of the responsible agencies direct conservation of Tahoe yellow cress and its habitat on public land (Appendix H). In general, most public agencies are mandated to protect Tahoe yellow cress and other listed and sensitive species and their habitats. Appendix J identifies the proposed conservation actions for core and high priority restoration sites owned by public agencies. However, there are three primary barriers to conservation on public lands: 1) Balancing stewardship with development and use of recreational facilities and access; 2) balancing stewardship with other land use; and 3) funding and resource allocation.

Conservation Goals, Objectives, and Associated Actions

The following conservation goals were developed to guide the management of Tahoe yellow cress and its habitat by participating entities. The protection afforded this species through existing policies and guidelines (Appendix H) is not affected by this conservation strategy, nor is the strategy intended to alter the current regulatory requirements of each appropriate agency. The conservation strategy has been developed not only to provide conservation and management guidance for Tahoe yellow cress, but also to affect the federal listing decision process. Successful implementation of the conservation strategy may preclude the need to federally list the species as well as provide grounds to downlist the species at the California and Nevada state levels. The goals and objectives that will serve as the foundation of the conservation strategy are articulated in Section II.F. Briefly, the goals are identified below:

Goal 1: Protect occupied habitat and potentially suitable habitat that does/could support natural populations.

Goal 2: Improve Tahoe yellow cress populations.

Goal 3: Promote conditions that favor a positive metapopulation dynamic.

Goal 4: Conduct research that directly supports management and restoration.

Goal 5: Revise and continue the monitoring program for Tahoe yellow cress.

Goal 6: Implement an interagency adaptive management framework.

Associated with each goal is a set of objectives and associated actions intended to achieve that goal. The actions described are general in nature. Site-specific actions for core sites and high priority restoration sites are listed in Appendix J. Additional actions not related to specific sites are listed in Table 14.

Description and Prioritization of Management Actions

The goals and objectives of the conservation strategy for Tahoe yellow cress are focused on affecting the conditions that influence a positive metapopulation dynamic. The following management actions were developed to ensure the conservation goals and objectives are directly supported through management. Efforts will largely focus on increasing the number of plants and populations across the species' historic range. This requires equal protection on

public and private lands, restoration efforts, monitoring, periodic evaluation and review, and ongoing adaptive management. These efforts should be designed to secure current populations against extirpation and to increase their numbers, to expand the current distribution of populations to new and historic sites, to sustain existing and newly established populations over the long-term, and direct future management action though adaptive responses informed by monitoring and research. The following actions provide the necessary support for the Tahoe yellow cress conservation strategy and its goals and objectives.

- Protect priority ranked sites that support persistent natural populations.
- Develop site-specific management/action plans for each core and high priority restoration sites.
- Manage all sites that currently support Tahoe yellow cress.
- Carry out experimental reintroduction efforts.
- Monitor natural and reintroduced populations.
- Develop an interagency low population fencing and management permit.
- Maintain a site ranking for every site based on new and historic information.
- Identify management and monitoring responsibilities (Table 14).
- Consider revisions to existing TRPA MOUs.
- Consider development of a "Safe Harbor" program.
- Solicit recommendations from the Tahoe Yellow Cress Stewardship Group (TYCSG).
- Address water level management within Lake Tahoe.

Adaptive Management Framework

The Tahoe yellow cress conservation strategy depends on successful implementation of an adaptive management framework designed to integrate new information immediately into management direction. A step-down outline of the framework is presented in Figure B (corresponds to Figure 18 in strategy). It briefly describes the key steps in acquisition, transfer, storage, analysis, and assessment of data from monitoring and research. It is important to recognize that while participating entities will be committed to implement the conservation strategy, they may chose to go beyond expected responsibilities or dissect described steps to better articulate intended tasks. Each of the steps presented in Figure B are requisite to ensure the success of the conservation strategy. It is critical that the signatories provide the resources necessary to ensure successful implementation of the adaptive management framework. Until an adaptive management working group is established, the TAG will report to the executive committee.

Imminent Extinction Contingency Plan

A necessary component of any conservation strategy and/or adaptive management framework is to define the types and degree of actions to be taken when the number of populations and/or the sizes of populations become critically low. This kind of pre-planning for future actions is necessary for the following three reasons: 1) There may be insufficient time between the

identification of an imperiled population and need to take action; 2) the description of possible actions to be taken to save the species will be known to all stakeholders in advance; and 3) the level of effort and resource commitment is acknowledged by all agencies and stakeholders. Four levels of contingency plans based on the number of occupied core sites and other sites have been identified (Section II.I). In general, when the number of occupied population sites decrease, effort will increase to conserve this species.

Stewardship, Education, and Outreach

Successful implementation of the conservation strategy shall include the development of a stewardship program in which private landowners and public agencies may participate (Section II.J). The stewardship program will be designed to be a cooperative educational effort that encourages public and private landowners, facility managers, and non-governmental agencies to manage for the conservation of Tahoe yellow cress and, if possible, generate site-specific management plans. The Tahoe Lakefront Owners' Association has volunteered to organize a Tahoe Yellow Cress Stewardship Group. This will be a non-profit group whose mission will be to encourage the conservation of Tahoe yellow cress on private lands. Although this group has yet to be formed, Tahoe Lakefront Owners' Association currently plays an integral role in communicating to those it represents the importance of conserving Tahoe yellow cress on private lands. Establishing this foundation will assist in the promotion of the stewardship program.

Monitoring, Science, and Research Agenda

An effective survey protocol will be implemented that includes a reliable census of known populations and systematic searches of unoccupied but suitable habitat areas (Section II.K). In addition, physical and biotic conditions that are thought to determine Tahoe yellow cress presence and abundance should be assessed in order to develop a more complete understanding of the environmental correlates of habitat suitability. That knowledge will then be used to guide future management actions, especially to provide early warnings of imminent species declines.

Hope for the Future

Through this cooperative effort, parties to this conservation strategy hope to successfully conserve Tahoe yellow cress and its habitat well into the future. Implementing this strategy and remaining committed to an adaptive management process will allow new information to be incorporated into existing management and provide a mechanism for an unprecedented level of cooperation between regulatory and resource agencies and private entities in the Lake Tahoe basin.

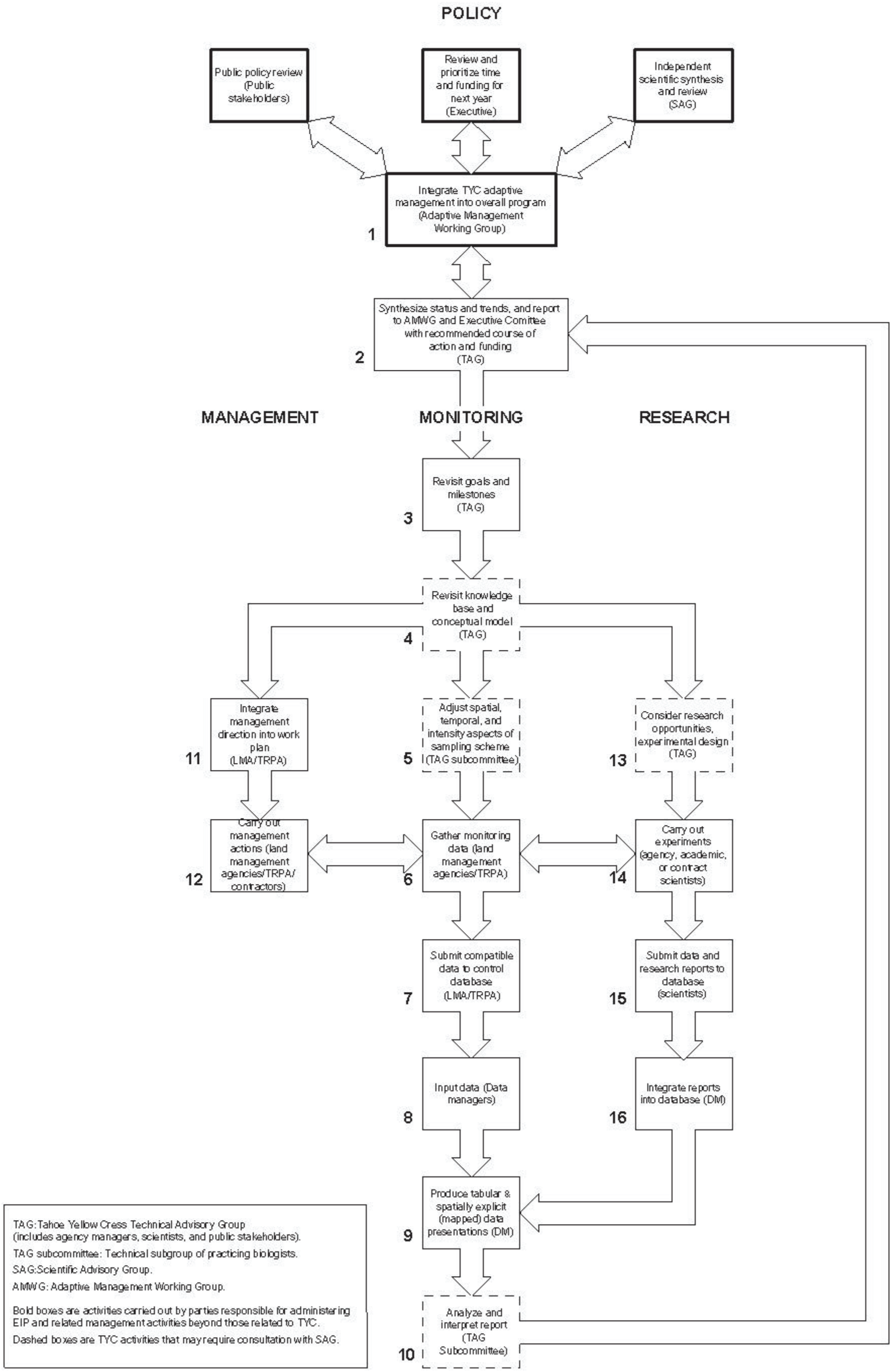

Figure B. Adaptive managment framework and assignments